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URE INTERVALS

ACOUSTIC RATIO USED
VERTICALLY *and* HORIZONTALLY

BY

Thomas Horace Evans, M.D.

(Certificate in Music, The School of Fine Arts,
University of Pennsylvania.)

Chandler-Ebel Music Co.
434 Albee Square
Brooklyn, N. Y.

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ACOUSTIC RATIO APPLIED TO COUNTERPOINT INTRODUCTORY

(CORRECT INTERVALS used in combination, vertically and horizontally).

§ Something more exact than the mere intervals in each vertical adjustment, in COUNTERPOINT, or in the steps from note to note of the harmonic structure, will be obtained if the correct RATIO of the step (or leap) be applied. Those who are not aware of the diatonic variation of note (a raising or lowering by a musical "comma," or the ratio of a logarithm of 5 points, to accommodate pitch to the necessities of the Upper and the Lower tetrachord) can soon discover the freedom with which musical composition responds when the exact ratio of each leap from note to note is given a correct interval.

TWO TETRACHORDS FORM THE SCALE SEPARATED BY A DIATONE

§ Elaborate details might be given here, but the first need is to establish the intervals of the tetrachords. In the **lower tetrachord**, the second step must agree with the fourth note in the ascending scale. This makes it at a normal minor third (ratio 5/6; in the logarithmic series, an interval denoted by 79. As the limits of the perfect fourth are at 125, this, if subtracted, leaves 46 to represent the step from the first note to the second. This is the CLOSE DIATONE, and is at a 9/10 ratio).

§ The third note of the lower tetrachord (in the major scale) is at a major third from the first note, and is at a ratio of 4/5. In logarithmic notation this is 97. If 97 be taken from the notation or logarithm of 125, there remains 28, which is the notation of the

interval from the third note to the fourth, in this tetrachord. The ratio is 15/16. This is the normal **semitone interval,** of the Leading note. It occurs in the upper tetrachord between the seventh and the octave.

§ In the **upper tetrachord** the same steps recur from first to fourth note. However, the distance between the two tetrachords, important to establish, is found by noting the diatone as that of the WIDE step (diatonic): As the Octave is represented by the logarithm of 301, to subtract the combined logarithms of the two tetrachords, namely twice 125 (=250) we obtain 51, which is the notation of the WIDE diatone. The ratio of this is 8/9. We add or subtract the notation in logarithms, to establish the correct steps. But the fractional notations must be multiplied, or divided, to represent additions or subtractions of steps, in measuring by fractions, for the elevations or depressions, which occur in the leaps.

CHANGE IN EXACT PITCH, DUE TO CORRELATED INTERVAL

§ When the COUNTERPOINT (or the base and melody of the harmony) requires combinations vertically relating to both tetrachords at the same time, **a change in the step** may be needed. That is, the wide or the close diatone may be varied one to the other, and before this, and after it, all leaps will be correspondingly raised or lowered by a comma (or a 5 log). The fractional variation is 80/81. That this is too small an interval to recognize, is true. But as it tends to increase or decrease, with repetition of the melodic design, it results in a final change of pitch, and this leads to musical confusion (unless accounted in a "rational" return).

§ The change may be cared for in several manners. It may be obviated. This is done by avoiding such suggestions as require modification, and the COUNTER-POINT, although restricted, is then very pure. Or, if the change has occurred, it may later on be neutralized, and a correct return to tonality be effected.

§ It is important to see that the change occurs by representation in all parts of the coincident music. In some compositions, the change is represented in one part and not in another. This leads to uncertainty of rendition.

§ For example, if the leap is from the dominant to the second note of the scale, it should be that of a perfect fourth, yet this is not a leap to the second note of the lower tetrachord, as mentioned in the previous paragraphs. For a perfect fourth (at 125) would leave the difference of 51 and not that of 46 logarithm. So the perfect fourth below the dominant is at a WIDE DIATONE from the tonic or first note of the lower tetrachord. This is seen if we multiply the ratio of 8/9 by that of 3/4, which equals 24/36 (or 2/3): Two-thirds is the ratio of the perfect fifth. If this be multiplied by three-fourths, there is obtained 1/2, which is the ratio of the octave. It is seen by logarithms: 301 (Octave) losing 125 (perfect fourth) leaves 176, which is the logarithm of a perfect fifth, and the perfect fourth plus the perfect fifth equal the octave, in pitch, in vibration ratio (fractionally), and by logarithm.

COMPOSITION

§ The writer of music should determine, for each leap, whether this will bring the horizontal part in correct ratio or fractional interval with the point at which the other part or parts, may be located. Some surprizes

are in store for a composer who has not measured up these concomitant leaps or steps, and he may discover in many TEXTS of COUNTERPOINT that notes assigned to sound together have passed to their stations by a ratio which separates them by a comma, rather than combining them at a true musical interval.

PROOF

§ It will be found that the Relative minor is located upon the correct second step of the upper tetrachord, which is at a a CLOSE DIATONE from the dominant. (This is at 9/10 ratio, fractionally, and at 46 logarithm). But no amount of reasoning will allow the next move to add (to this note of the relative minor) the leading note of the dominant, to form what was expected to prove a MINOR THIRD in the counterpoint. If the 28 of the semitone be added to the 46 of the other step it gives 74. But the logarithm of a true minor third is 79. The ratio of the minor third is 5/6: This subdivides into the semitone and the wide diatone. Fractionally, it is represented by 15/16 x 8/9 = 120/144 = 5/6. But the second step of the upper tetrachord must be raised by 80/81 to agree with the leading note of the dominant, and this destroys its validity as a note upon which to found the scale of the relative minor.
[Note: Logarithms are approximate]

§ In this manner, all modulations may be shown to be either logical, or, not (acoustically sound). A very beautiful effect is obtained by regard for the exact steps by interval. More effects are possible in this method, as fine modulations are available without using sharps or flats; and equally tempered instruments, such as the piano, begin to give out such music as is hinted at by

Professor Hugh Archibald Clarke, in the closing pages of his HARMONY.

§ Professor J. Zahm, of Notre Dame, has explained the methods of measurement. Charles Villiers Stanford has advised contrapuntal care in the use of the fractional ratio indices. Plenty of advice (as to the need of acoustic measurements) from Cherubini exists, but very few students apply it. In NOTE AGAINST NOTE, it freshens up the entire work. In treatment of base (bass) it is very helpful. In fact, all parts respond gratefully to correct leaps as well as correct intervals, so—called, vertically. Intervals exist **horizontally** as well as **vertically.** In modern uses, ornamental notes may be applied around the firm structure of exact interval. But so far as it goes, the measurement should be calculated, primarily.

RULE

§ Measured leaps, in all concomitant parts, must accord in resultant levels. If they do not, the parts conflict in tonality. Suspensions may be used to lead, by ascent or descent, diatonically, or by normal leap, to consonant resolution. No single diatone can be analyzed.

COROLLARIES

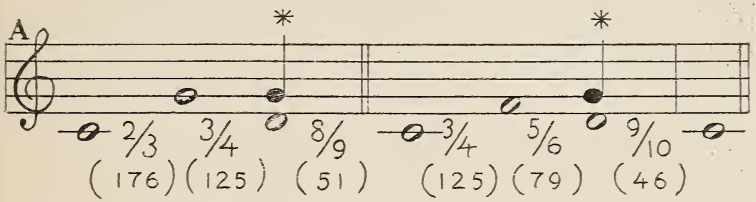
§ In the Lower tetrachord, the **lowered second** step (d—flat in C—natural major) is at a major third below the fourth step (F—natural, in C—natural major). This lower step is, therefore, at a WIDE DIATONE from the lowered third step (E—flat, in C—natural major). And the lowered third step is at a CLOSE DIATONE from the fourth step, consequently. The **leading note to the lowered third,** is, however, at a WIDE DIATONE from

the first step or key–note (d–natural, to C–natural, in C–natural major). But this note (second step treated as a leading note to the lowered third) is not at a true minor third below the fourth step, but is a true fourth to the dominant (G–natural, in C–natural major) and is, therefore, annectant to the dominant, is its dominant, and also the leading note to the major scale upon the lowered third (E–flat major, in C–natural major). Construe all this for the upper tetrachord, bearing upon the **lowered sixth**, in relation to the scale upon the fifth step.

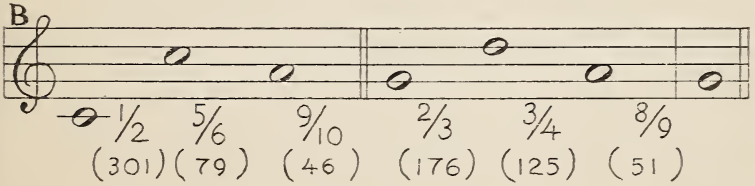
§ The **leading note to the dominant** (F–sharp, in C–natural major) is a major third above the higher second step (d–natural) which is at a WIDE DIATONE to the original key note. There is another F–sharp which is at a major third above the lower second step, and relates to a lowered dominant, which is, in the key of the sub–dominant, a second step at a CLOSE DIATONE above the sub–dominant.

§ The **flatted seventh step** is at two levels. One is a true minor third above the dominant, and at a CLOSE DIATONE below the octave of the original key note; the other is lower, and at a WIDE DIATONE to this octave, and also at a true fourth to the sub–dominant.

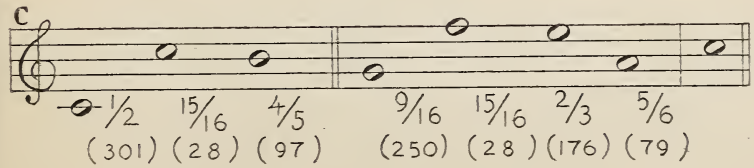
EXERCITATIONS:

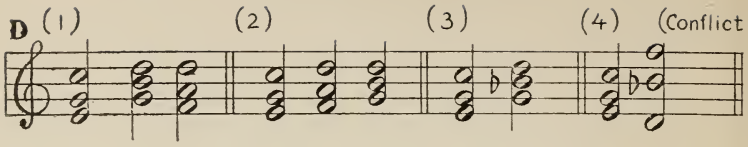


Observe: that the note "D" varies in pitch, although modern notation cannot show that it does. It will render differently by voice or by violin. The first "D" measures 3/4 (125) to G. The second "D" is lower and at 20/27 (130), due to leaps from F, and C, in series.



Observe: that the note "A" varies in pitch, the former being at the level of the relative minor, the latter being in the key of G and too high by a "comma," or log of 5 (80/81 ratio), due to approaches.





(1) : The F–natural is higher than the normal sub–dominant.

(2) : The G–natural in third chord is lower than the dominant.

(3) : This can be written, and correctly measures up. (but is not in F–natural)

(4) : This should not be written, for the G–natural cannot leap a correct 5/6 to the b–flat needed to measure up for the F–natural at 3/4.

TERMINOLOGY

§ Owing to the variant pitch of the STEPS of the Scale, when used in COUNTERPOINT (or basal harmonic progressions) it is desirable to supply names for these points (or notes) of pitch in correlation to the KEY–NOTE.

§ The Key–note is termed: THE EXPONENT (of the key).

OCTAVE	=	OCTAVE, (or Tensive LIMIT).
Leading note	=	RECTOR, (or Tensive Director).
(Lowered idem	=	VECTOR).
Sixth	=	RELATIVE, (or Tensive VERSOR).
Lowered sixth	=	INTENSOR
Fifth	=	TENSOR, (Extensor, of the Dominant).
Fourth	=	LIMIT, (being the limit of each tetrachord).
Third	=	DIRECTOR, { Intensive (minor) / Extensive (major) / Its raising or lowering operating to effect change of axis.
Second	=	VERSOR, (acting upon the DIRECTOR).
Raised key–note	=	PRAE–VERSOR, (sharped).
KEY–NOTE	=	PONENT, (in the tetrachord) EXPONENT (in the Scale).
Lowered Key–note	=	INVECTOR, (flatted).

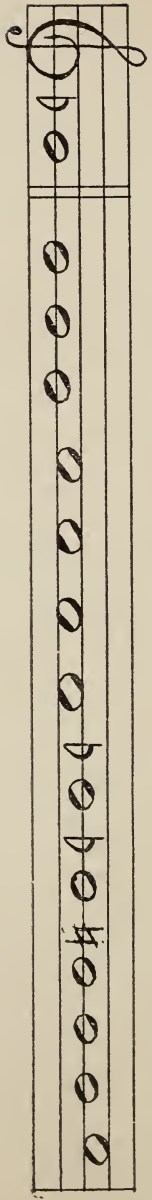
§ (a) The VERSOR (in the Scale) is either:
EVERSOR (if at 8/9 to Key–note).
REVERSOR (if at 9/10 to Key–note).

§ (b) The RELATIVE, if at 8/9 to TENSOR, becomes the IRRELATIVE, and is higher than the point of the relative minor.

§ (c) The Leading note to the Fifth (raised fourth) is the ADVERSATIVE.

§ The Dominant seventh Chord is the "Extensive" harmonic system.

CHART



Per-limit	
Retensor	Fifth to Deponent
Extensor	**Normal**
Super-tensor	Fifth to Superponent
Subverse tensive	Fifth to Subversor
Relative	Fifth to Reversor
Irrelative	Fifth to Eversor
Obverse tensive	Fifth to Obversor
Limiting Vector	(8/9 to Octave)
Elimiting Vector	(9/10 to Octave)
Reponent	Sixth to Reversor
Proponent	Leading-note
Opponent	Sixth to Obversor
Octave (Upper Limit)	Fifth to LIMIT

Note: Variants are at 80/81 ratio (or at 5 Log approx.)

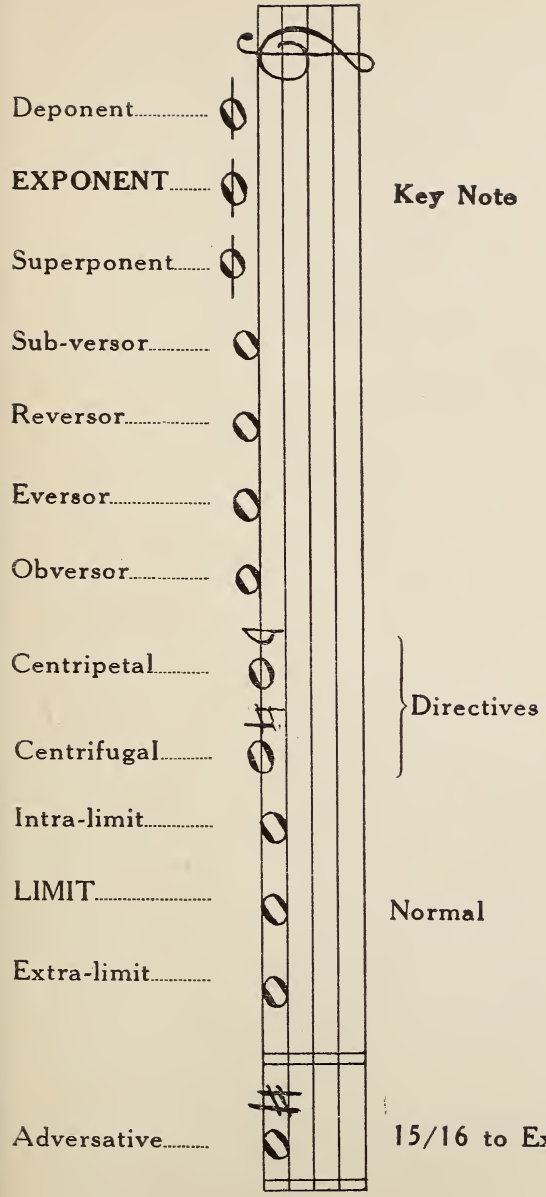


Table of Measurements